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Heavy quark production and the initial stages: progress and open questions

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The initial stages of ultra-relativistic nucleus-nucleus collisions are not well constrained. In particular, the number of initially produced heavy-quark pairs, part of any initial conditions required for modeling, is not well known. When the heavy-quark pair production in nucleus-nucleus collisions is estimated based on an extrapolation from proton-proton collision measurements, this is mainly driven by the lack of our knowledge of the gluon densities at low longitudinal momentum fraction of the nucleus.

In this presentation, I will give an experimentally-driven overview of the significant progress of our knowledge on these gluons via inclusive heavy-quark production in proton-nucleus and exclusive gamma-nucleus collisions at the LHC. I will point out the conceptual caveats related to both types of measurements in view of their interpretation as initial state constraints of nucleus-nucleus collisions. In this context, I will mention their potential beyond density constraints and the role of these measurements for an open question in hadron structure physics, the quest for gluon saturation. I will argue that, firstly, we see the emergence of a coherent picture of strong gluon depletion in the nucleus compared to the proton and that, secondly, experimental and theoretical progress is under way to solidify and quantify better this picture.

Finally, I will comment on charm production during the preequilibrium stage in ultra-relativistic heavy-ion collisions, the phase between the initial hard scatterings and the phase described by viscous hydrodynamics. This production contribution is usually coined ´thermal´ production. It is non-negligible, but suffers from large theoretical uncertainties. Nonetheless, it can provide us experimental information on the preequilibrium stage and hence the thermalisation process in heavy-ion collisions, if precise measurements of total charm production and precise calculations are conducted.

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